Interim Contractor Report #21

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Investigation of the Large Scale Evolution and Topology of Coronal Mass Ejections in the Solar Wind

Dr. Pete Riley
SAIC
10260 Campus Point Dr.
MS E3X
San Diego, CA 92121

SciberNet, Inc.
5414 Oberlin Drive, Suite 251
San Diego, CA 92121

Summary of Work

MHD and Hybrid Simulations of CMEs

During this reporting period we have identified and analyzed a series of low-density intervals in the ACE plasma data, some of which match events previously identified by others in the WIND data set. These WIND events have been associated with a variety of geomagnetic activity at Earth. Although the cause of these events remains unclear at the present, we believe they may represent some type of transient activity akin to coronal mass ejections. In several cases, counter streaming suprathermal electrons were seen in the vicinity of the structures, indicating a closed magnetic field line topology. In some events, a rotation of the magnetic field was observed, suggesting a flux-rope topology. These events are often associated with increased variability in the ratio of doubly ionized helium to protons. Again, this signature is often associated with CMEs. Of course, unlike CMEs, these events are not associated with the expulsion of mass. Nevertheless, the association of many CME-like features is suggestive that the two are related and/or similar causes may responsible for both.

These "density holes" have other unique features. They are often associated with a decrease in temperature. Thus the thermal pressure decreases across the structures. Often, there is not a corresponding increase in magnetic field strength, suggesting that they are not in pressure balance. The speed profiles are often flat, or slightly inclined, indicating expansion. However, this expansion is not sufficiently large to be explained by the expulsion of an initially high-pressure pulse. The speeds are typically low (~400 km/s). The relationship between density, temperature and speed is unusual for unprocessed solar wind. Typically fast, coronal flow is hot and tenuous, whereas slow, equatorial flow is dense and cold.

Using a 3-D MHD model, we have begun to model the structure of the solar corona during the intervals containing these density holes. Although the model provides only a simplified picture of processes in the corona, if regions of slow, tenuous flow are identified, it may lead to a picture of the cause of these structures.

Finally, we made revisions to two manuscripts concerning CME properties in the solar wind.

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Dr. Peter Riley

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SciberNet, Inc.
5414 Oberlin Drive, Suite 251
San Diego, CA 92121

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This investigation (subcontract Sci-0201-99 of contract NASW-98007) is concerned with the large-scale evolution and topology of Coronal Mass Ejections (CMEs) in the solar wind. During this reporting period we have analyzed a series of low density intervals in the ACE plasma data set that bear many similarities to CMEs. We have begun a series of 3D, MHD coronal models to probe potential causes of these events. We also edited two manuscripts concerning the properties of CMEs in the solar wind. One was re-submitted to the Journal of Geophysical Research.

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